ORGIA INSTITUTE OF TECHNOLOGY — OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[x] ORIGINAL [ ] REVISION NO. _____

oject No. E-16-643 GTRI/~~GIT~~ xxxx DATE 3/14/83

oject Director: Warren C. Strahle School/Lab xxxx AE

onsor: Office of Naval Research
Arlington, VA 22217

ype Agreement: Grant No. N00014-83-G-0047

ward Period: From 2/15/83 To 2/14/84 (Performance) _____ (Reports)

onsor Amount: Total Estimated: $ 50,061 Funded: $ 10,000

ost Sharing Amount: $ _____ Cost Sharing No: _____

tle: Workshop on Mechanisms of Instability in Liquid Fueled Ramjets

DMINISTRATIVE DATA

OCA Contact John W. Burdette x4820

Sponsor Technical Contact:
eader Mechanics Division
esearch Programs
Office of Naval Research
800 North Quincy St.
Arlington, VA 22217

2) Sponsor Admin/Contractual Matters:
Mary Ann Cook
Office of Navy Research
800 North Quincy St.
Arlington, VA 22217
Phone (202) 696-4514

efense Priority Rating: NA

Military Security Classification: NA
(or) Company/Industrial Proprietary: NA

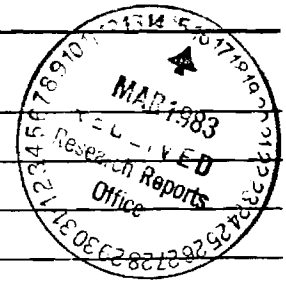
ESTRICTIONS

ee Attached _____ Supplemental Information Sheet for Additional Requirements.

ravel: Foreign travel must have prior approval – Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

quipment: Title vests with None proposed

OMMENTS:



OPIES TO:

esearch Administrative Network
esearch Property Management
ccounting
Research Security Services
Reports Coordinator (OCA)
GTRI
Research Communications (2)
Project File
Other Strahle

EORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION/CLOSEOUT SHEET

2990
2R

Date June 5, 1985

oject No. E-16-643 School/~~Unit~~ AE

cludes Subproject No.(s) N/A

oject Director(s) Warren C. Strahle GTRC / ~~GIT~~

onsor Office of Naval Research, Arlington, VA 22217

tle Workshop on Mechanisms of Instability in Liquid Fueled Ramjets

fective Completion Date: 2/14/84 (Performance) 2/14/84 (Reports)

ant/Contract Closeout Actions Remaining:

- [ ] None
- [X] Final Invoice or Final Fiscal Report
- [ ] Closing Documents
- [X] Final Report of Inventions
- [X] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other

ntinues Project No. Continued by Project No.

OPIES TO:

oject Director
esearch Administrative Network
esearch Property Management
ccounting
ocurement/GTRI Supply Services
esearch Security Services
eports Coordinator (OCA)
egal Services

Library
GTRC
Research Communications (2)
Project File
Other Heyser

Jones

ORM OCA 69.285

CPIA PUBLICATION 375
APRIL 1983

ONR/AFOSR WORKSHOP ON MECHANISMS OF INSTABILITY IN LIQUID-FUELED RAMJETS

TOWER PLACE HOTEL
Atlanta, Georgia
16-18 MARCH 1983

CHEMICAL PROPULSION INFORMATION AGENCY
Operating under contract N00024-83-C-5301
THE JOHNS HOPKINS UNIVERSITY • APPLIED PHYSICS LABORATORY • LAUREL, MD.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER CPIA Publication 375	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) ONR/AFOSR Workshop on Mechanisms of Instability in Liquid-Fueled Ramjets		5. TYPE OF REPORT & PERIOD COVERED Workshop Proceedings 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Debra Sue Eggleston, Editor		8. CONTRACT OR GRANT NUMBER(s) N00024-83-C-5301
9. PERFORMING ORGANIZATION NAME AND ADDRESS Johns Hopkins University Applied Phys Lab--Chem Prop Inf Agy Johns Hopkins Rd, Laurel, MD 20707		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Plant Representative Naval Plant Rep Ofc; Johns Hopkins Rd Laurel, MD 20707		12. REPORT DATE April 1983 13. NUMBER OF PAGES 307
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) Commander Naval Sea Sys Comd (NSEA-62R22) Washington, DC 20362		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Distribution limited to U.S. Gov't. agencies only; test and evaluation; Apr 1983. Other requests for this document must be referred to the Office of Naval Research, Propulsion and Energetics Group, Code 432P, Arlington, VA 22217.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Copies available from CPIA only. Reproduction not authorized except by specific permission.
U.S. State Department's International Traffic-in-Arms Regulations prohibit export or transmittal to non-U.S. citizens without validated export license.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

acoustics	inlet response	pressure oscillations
combustion instability	inlet unstart	vortex shedding
entropy waves	liquid fueled ramjets	
fluid mechanics	nozzle response	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This publication contains twenty papers and the recommendations and conclusions which were presented at the ONR/AFOSR Workshop on Mechanisms of Instability in Liquid-Fueled Ramjets, held 16-18 March 1983 in Atlanta, GA. The workshop focused on physical and chemical processes of importance in the problem of instability in liquid-fueled ramjets. The purpose was to generate a consensus of needed research in this area.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-014-6601

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Proposal

Submitted to

The Office of Naval Research

Power Branch

by

School of Aerospace Engineering

Georgia Institute of Technology

Atlanta, GA 30332

WORKSHOP ON MECHANISMS OF INSTABILITY IN LIQUID FUELED RAMJETS

Warren C. Strahle
Principal Investigator

A. L. Ducoffe, Director
School of Aerospace Engineering

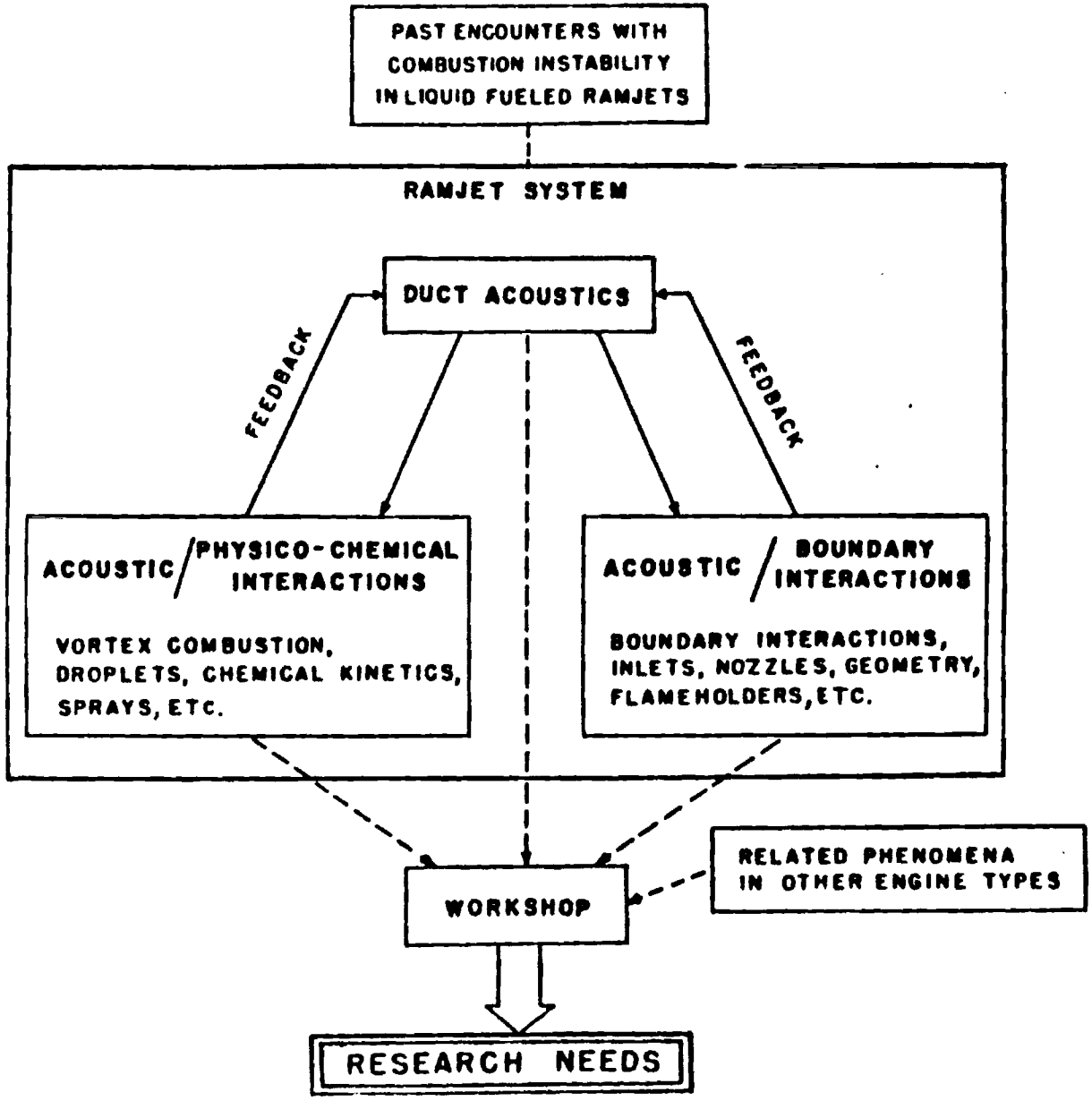
Jerry Goldbaugh
Contracting Officer

INTRODUCTION

As with virtually all high heat release rate density propulsion systems, there are several liquid fueled ramjet systems which have encountered combustion instability[1]. Except with regard to solid propellant rockets, which have little in common with liquid ramjets, the combustion, fluid mechanics and propulsion community has been relatively silent in recent years in research on instability mechanisms in propulsion systems. Current needs, however, demand a resurgence of work in this area.

The practical problem of ramjet instability involves several fundamental areas that have evolved rather independently as applied science disciplines, and it is necessary to bring these together in the context of the practical problem. Figure 1 depicts the fundamental areas that are of interest in the problem. Discussions within the community of interested scientists and engineers[2] has led to the proposition of a workshop as a means of clarifying the status of relevant disciplines and stimulating interaction and cooperative research on the interdisciplinary problem of ramjet combustion instability.

The purpose of this proposal is to provide the basis for a Georgia Tech/Office of Naval Research Workshop on mechanisms of instability in liquid fueled ramjets. The workshop would have as its goal the establishment of research needs in this area of propulsion.


PAST ENCOUNTERS WITH COMBUSTION INSTABILITY IN LIQUID FUELED RAMJETS
RAMJET SYSTEM
DUCT ACOUSTICS
FEEDBACK
FEEDBACK
ACOUSTIC / PHYSICO-CHEMICAL INTERACTIONS
VORTEX COMBUSTION, DROPLETS, CHEMICAL KINETICS, SPRAYS, ETC.
ACOUSTIC / BOUNDARY INTERACTIONS
BOUNDARY INTERACTIONS, INLETS, NOZZLES, GEOMETRY, FLAMEHOLDERS, ETC.
RELATED PHENOMENA IN OTHER ENGINE TYPES
WORKSHOP
RESEARCH NEEDS

PROPOSED TITLE

The title of the Workshop would be: "Mechanisms of Instability in Liquid Fueled Ramjets".

SPONSOR

The monetary sponsor would be the Office of Naval Research. The workshop credits would read ONR/Navsea/Navair/AFOSR/AFAPL.

SCOPE STATEMENT

The workshop will bring together representatives from government, industry and universities to discuss and define the limits of understanding and interrelationships between fundamental processes in the field of liquid fueled ramjet instability. The output desired is a statement of basic and applied research needs in this problem area.

ORGANIZATION OF WORKSHOP

Administrative aspects of this Workshop would be managed by the Georgia Institute of Technology (GIT) with concurrence of the Office of Naval Research (ONR) on general policy. Technical organization would be managed by the Principal Investigator (PI) at GIT, utilizing an organizing committee of the following persons in the indicated disciplines:

Professor Edward W. Price School of Aerospace Engineering Georgia Institute of Technology	Related Propulsion System Instability Experience where it has relevance to the LFRJ

Professor William A. Sirignano, Director Dept. of Mechanical Engineering Carnegie-Mellon University	Acoustic/Physico- Chemical Interactions
Professor F. E. C. Culick Dept. of Aeronautical Engineering California Institute of Technology	Acoustic/Boundary interactions and acoustics

This committee would be responsible for the selection of active technical participants, the technical program, session chairmanship and initial reporting of results. The PI will coordinate this committee, act as general advisor and be responsible for final reporting of results. Moreover, the PI, in liason with ONR, would monitor the program as it develops to assure compatability with relevant DOD desires. The PI will act as General Chairman of the Workshop and coordinate final discussion sessions.

SCHEDULING DETAILS, CONTENT, FORMAT, REPORTING

The details are to be developed by the Organizers. However some preliminary understandings are noted here as guides:

1. The Workshop dates have been chosen as 16-18 March, 1983. The site will be the Tower Place Hotel in Atlanta, GA.

2. An organizational meeting is proposed for each of the three technical specialty areas, to achieve a preliminary agreement on state of knowledge. These organizational meetings would involve about 5 persons each, for 1 to 1 1/2 days.

3. The Organizers of each specialty area are responsible that relevant aspects of their specialty are represented in both the Organizational Meetings and Workshop.

4. The Workshop will be invitational with the PI, Organizers and Technical Monitor being responsible for invitations. Committments to financial aid for participants will be made by the PI in consultation with the Technical Monitor. Active Participants will be limited to roughly 20 persons, with roughly 30 more observers.

5. The Organizers will prepare review papers, to be available for distribution at the Workshop. The Participants will prepare 2000 word Extended Abstracts, to be available at the Workshop. The Organizers' papers should summarize the state of knowledge within their overall disciplines, as related to ramjet instability. The Participants' Extended Abstracts should concentrate on the science aspects of their area, independently from ramjet systems implications. They should define a set of needed research areas in their discipline.

6. Formal presentations will last about 25 min., with a substantial time allotment for discussion.

7. At the close of the formal presentation an open discussion will finalize recommendations for research needs. The PI will lead this effort.

8. The PI will prepare a Summary Report after the Workshop.

REFERENCES

1. R. S. Brown, et al, "A Literature Survey of Ramjet Combustor Instability" presented at 19th JANNAF Combustion Meeting, October 7, 1982.

2. Meeting of Navy, JHU/APL and GIT personnel at ONR Headquarters, October 8, 1982.

ESTIMATED BUDGET

Notes:

1. Two methods have been used to estimate the budget, differing in the overhead charge. In Method #1 overhead is only charged against salaries, fringe benefits, travel and supplies for GIT personnel. In Method #2, overhead at the approved rate is charged against all expenditures.

2. It is currently planned that there will be 14 Participants and 3 Organizers. It is assumed there wll be one absentee at each of the Organization Meetings.

PERSONAL SERVICES

Salaries

*	PI (0.1 my)	7703	
*	Secretary (0.15 my)	2155	
*	Area 1 Organizer, E W Price (flat fee)	3000	
	Area 2 Organizer, W A Sirignano (flat fee)	3000	
	Area 3 Organizer, F E C Culick (flat fee)	3000	
	Total Salaries	$18,858	
*	Fringe Benefits (21% of Salaries for W C Strahle, E W Price and secretary)	2700	
	Total Salaries and Fringe Benefits		21,558

TRAVEL FOR WORKSHOP PARTICIPANTS

Transportation

	Organization Meetings (14 persons @ $325/man)	4550	
	Workshop (17 persons @ $400/m)	6800	
*	PI arrangement trips (2 trips)	600	
	Total Transportation	$11,950	

Accomodations

	Organization Meetings (14 persons @ $45/day for 2 days)	1260	
	Workshop (17 persons @ $52/day for 3 days)	2652	
*	PI (2 nights @ $45/night)	90	
	Total Accomodations	4002	

Meals

	Organization Meetings (14 persons @ $20/day for 2 days)	560	
	Workshop (17 persons @ $20/day for 3 days)	1020	
*	PI (2 days @ $20/day)	40	
	Coffee at Workshop (3 days @ $100/day)	300	
	Total Meals	1920	
	Total Travel		17,872

GENERAL EXPENSES

*	Telephone ($200 per Organizer and PI)	800	
*	Printing and Mailing (Reports and Notices)	1200	
	Total General Expenses		2000
	TOTAL DIRECT CHARGES		$41,430

Overhead (47.2% of Costs by two methods.
Method #1 applies overhead to those lines marked with an asterisk.
Method #2 applies overhead to the Total Direct Charges)

Method #1, $8631 ~~Method #2, $19,555~~

TOTAL PROGRAM COST	Method #1	$50,061
	~~Method #2~~	~~$60,985~~